

NOTES ON THE ACOUSTIC SIGNALS OF A NEOTROPICAL SATYRID BUTTERFLY

STEPHANIE KANE

Department of Zoology, The University of Texas,
Austin, Texas 78712*

ABSTRACT. Acoustical signalling is documented for the satyrid, *Pharneuptychia* nr. *pharnabazos*. The clicking sounds are produced during specific flight behaviors. The sounds have been identified from males only to date, but no structures or mechanisms for producing the sounds were identified.

Sound production in butterflies is a sporadic phenomenon, largely reported in the genus *Hamadryas* (Nymphalidae) (Darwin, 1871; Fruhstorfer, 1924; Ehrlich & Ehrlich, 1961; Ross, 1963). Audible clicking sounds in flight are characteristic of this group, hence the common name of "crackers." The nature of their sound producing mechanism is as yet unresolved (Swihart, 1967). Acoustic signalling has also been observed in *Neptis hylas* (Linnaeus) (Nymphalidae) (Scott, 1968), which produces a slow clicking sound by snapping together its forelegs while in a resting position. This paper presents the first documented evidence of acoustic signalling in a satyrid butterfly. The signals consist of bursts of clicking sounds emitted during ritualized flight behavior. The butterfly was identified as *Pharneuptychia* nr. *pharnabazos* by Dr. Keith Brown; however, the specimens appear quite similar to the plates in Seitz, Volume 5 (Plate 48d) called *Eupptychia pharella* (Butler) (Satyridae). For the purposes of discussion, I will call it *Pharneuptychia* nr. *pharnabazos*, although the identity is uncertain at this point.

Field Site and Method

Sound production was documented in the adult *Pharneuptychia* nr. *pharnabazos* between 0800 and 1000 h from 31 March to 4 April 1980 near the town of Senador Pompeu in the state of Ceará in northeastern Brazil (6°S latitude, 39°W longitude). A recording of the acoustic signals was made from 0900 h on 31 March with a Uher 4000L tape recorder, a Sony C-22 FET condenser microphone and parabola from a distance of 0.5 to 1.0 meter. Sound spectrograms were made on a Kay Electric Co., Type 6061-A sonograph using FL-1, linear scale, and wide-band filter settings. A copy of the recording was deposited in the Cornell Library of Natural Sounds and the Arquivo Sonoro Neotropical (cut S. Kane no. 17/1) of the Universidade Estadual de Campinas, São Paulo, Brasil. Voucher specimens were deposited in the American Museum of Natural History.

* Now in Dept. of Anthropology (same university).

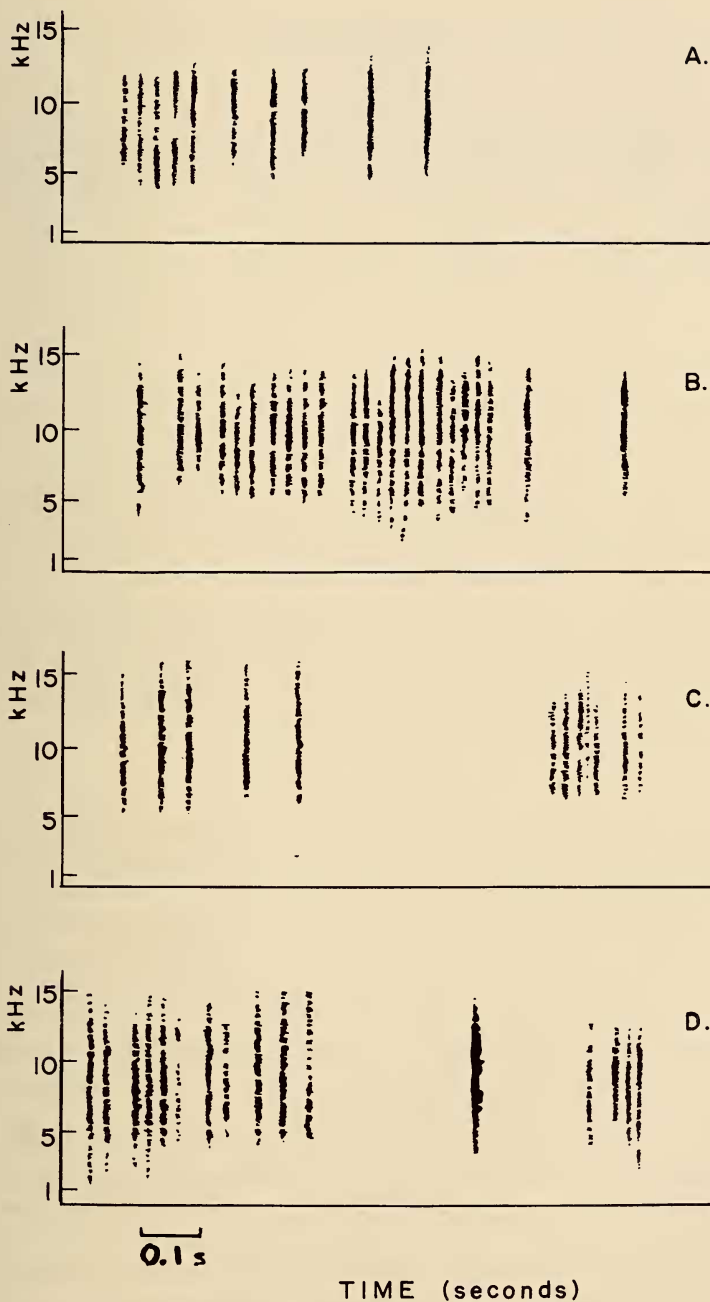


FIG. 1. Sound spectrograms representing 1.2 s segments of the acoustic signals of *P. nr. pharnabazos*.

Table 1. Bioacoustic Data

signal #	signal duration (sec.)	spectrogram	frequency range of spectrogram (kHz)	click rate of spectrogram (click/sec.)
1	1	A	4 - 13	19.6
2	4	B	5 - 15	28.4
		C	6 - 15	12.8
3	2	D	2 - 15	17.2

Fresh fruit of the Juazeiro tree (*Zizyphus juazeiro* Mart., Rhamnaceae) was cut up and distributed on rocks about 30 cm apart on the ground in a sunlit forest clearing. This attracted *P. nr. pharnabazos* and two other common fruit visiting species, *Hamadryas ferentina* Godart and *Anaea moretta* Druce (Nymphalidae). Intra- and inter-specific behavioral interactions were thereby observed with facility. Similar behavioral interactions were also observed along paths, other open woodland areas, and near fruiting trees.

Bioacoustic Analysis

Original recordings were made at 7½ ips. The spectrograms represent 1.2 s segments of recorded signals in the range of 800 to 16,000 Hz (see Fig. 1). The total recording duration is 32 s and consists of three signals from one or two individuals. The mean signal duration ($n = 3$) = 2.33 ± 1.53 s. The mean inter-signal duration ($n = 2$) = 12.5 ± 0 s. A signal is defined as one or more groups of clicks separated by neighboring groups by 12.5 s. The click is a broad band sound pulse with a range of frequencies between 4.25 kHz to 14.5 kHz for the greatest part of the amplitude of sound. Mean click rate per spectrogram = 19.5 clicks/s (see Table 1).

The sound producing mechanism is uncertain. It may be associated with wing beat, but this cannot be verified from the data presented, especially since, in some cases, two individuals may have been recorded simultaneously. A file system could produce the sounds as in crickets (Alexander, 1967). Unfortunately, the specimens had been crushed by the time they were examined microscopically and neither sound-producing, nor sound-receiving organs were apparent.



FIG. 2. Model of flight patterns of **A**) circling behavior and **B**) follow and chase behavior of 2 individual *P. nr. pharnabazos* butterflies. Relative strength of line indicates corresponding positions of individuals. Sounds are produced discontinuously throughout the movements.

Behavioral Notes

Auditory signals accompany ritualized flight behavior of two or three individuals. Sounds are produced discontinuously during circling and/or during follow and chase behavior (see Fig. 3). *P. nr. pharnabazos* usually flies about 10 cm off the ground, going up to 20 and 30 cm during the circle dance. Of six individuals collected, all are males. Three of these were clicking at the time of capture. It is not known if females produce sounds. Intraspecific encounters of another satyrid, *Erebia epipsodea* Butler (Brussard & Ehrlich, 1970), include ascending spiral flights and chasing behavior. These behaviors are also part of the intraspecific male territorial defense repertoires of *Archonias tereas* (Godart) (Pieridae) (Gilbert, 1968), *Papilio zelicaon* Lucas (Papilionidae) (Gilbert, pers. comm.; also described in Maynard Smith & Parker, 1976), and *Pararge aegeria* (Linnaeus) (Nymphalida) (Davies, 1978). Other genera of butterflies having male-male spiral chases are *Adelpha* (Nymphalidae), *Epiphile* (Nymphalidae), *Catasticta* (Pieridae), and some *Cissia* species (Satyridae) (pers. comm., Philip DeVries).



FIG. 3. Upper and under sides of the voucher specimen *Pharneuptychia* nr. *pharnabazos*.

The intra- and interspecific interactions described below strongly suggest that the acoustic signals of *P. nr. pharnabazos* accompany agonistic behavior in the presence of food and/or mates. These signals may also function as part of an intraspecific recognition code, maintaining contact between male and female individuals of a mobile group.

Intraspecific encounters of *Pharneuptychia nr. pharnabazos*:

1. Individual (A) approaches posed individual (B). A clicks briefly. A and B fly off, clicking while following and circling each other. Both pose again.

2. Two males in flight. There is clicking during alternating circle and follow behavior.

3. Two individuals (A, B) are posed. A third individual (C) approaches A, clicking and circling, chases off C.

4. Two individuals (A, B) encounter one another in flight. They fly soundlessly in the same direction until a third individual (C) appears. A separates from B and chases C, clicking. B and C pose near one another, flashing wings.

5. Individual (A) is feeding. Individual (B) approaches and waits 1 to 2 minutes. B then clicks and flies closely around A, crashing into A. B leaves and poses nearby for 2 minutes. B comes back and A is still feeding. B flies off to another piece of fruit some distance away but does not feed.

6. Individual (A) is feeding. Individual (B) is posed close to A. B clicks as a third individual (C) approaches. C flies away.

Interspecific interaction between *Pharneuptychia nr. pharnabazos* and *Hamadryas ferentina*:

1. *H. ferentina* (H) approaches two individual *P. nr. pharnabazos* butterflies (A, B). A takes off and flies, clicking around H. A third individual *P. nr. pharnabazos* (C) joins A, both click and fly after H. B remains feeding.

RESUMO

Este trabalho apresenta a primeira evidência de sinalização acústica de uma borboleta da família Satyridae, identificada como sendo *Pharneuptychia* aff. *pharnabazos* do nordeste do Brasil. Os sinais constituem-se em estálidos em séries, emitidos em ritual de vôo entre dois ou três indivíduos. Análise bioacústica dos sons gravados e as descrições de comportamento estão incluídas.

ACKNOWLEDGMENTS

I would like to acknowledge the welcome and orientation I received from the Zoology Department of the Universidade Estadual de Campinas, São Paulo, Brazil, and

the hospitality of the Sa Magalhães family. I am grateful to Cornell Natural Sound Library for their loan of recording equipment. I appreciate the editorial criticism of earlier drafts of this manuscript by Lawrence Gilbert and Philip DeVries, and the photo of *P. nr. pharnabazos* also by Philip. I thank Lincoln Stoller for his butterfly flight path drawing.

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